Paramagnetic liquid crystals in dielectric microcavities to construct magneto-optical resonators

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In recent years, works on magneto-optical effects in semiconductor microcavities has opened up a broad path in the development of new fields of physics and potential applications [1]. One of the still developing phenomenon is Faraday rotation, where the electric field vector of a linearly polarized light wave experiences a rotation when propagating through a media in the presence of a magnetic field. Faraday rotation has been demonstrated in a wide range of materials, from paramagnetic glasses to interstellar media, and has important applications in spintronics such as Faraday rotators, optical isolators, optical magnetometers and magnetic field sensors. Typically this effect is observed in inorganic compounds e.g. semimagnetic semiconductors, magnetic nanoparticles with permanent spin moments, i.e. unpaired electrons. By putting magneto-optical active material into microcavity it is possible to obtain an enhancement of Faraday effect. The article [2] authors show that in In(GaAs)/ GaAs QW the Faraday rotation of the light propagating in the microcavity is enhanced by multiple round trips during the lifetime of the exciton-polariton mode.

In this work we proposed similar structure based on dielectric microcavity with magneto-optically active organic material inside. As the main part of an ongoing research concerning efficient magneto-optical materials [3], liquid crystalline materials containing paramagnetic ions in their structure were synthesized, inter alia: copper, vanadium were tested mainly for their magneto-optical responses and magnetic properties. In addition to the differences resulting from different paramagnetic ions in the structure of these compounds, some liquid crystals with copper differing in the number of functional groups were additionally measured. For thin organic materials in crystalline form at room temperature the value of Verdet constant is giant and approaches 10^4-10^5 °/T·m - which is about 1-2 orders of magnitude larger than for inorganic compounds. Moreover for the first time, we report an observation of a giant Faraday rotation in thin film of crystalline liquid crystal with paramagnetic ions. Our novel method to measure extremely weak signals form organic structures is based on magneto-optical resonator used to enhance Faraday rotation. Apart from strongly important materials characterization (using: polarizing microscope, UV-Vis spectroscopy, profilometer, SQUID magnetometry, Faraday effect and EPR) we show also first attempts to detect enhancement effect in dielectric microcavity. This new approach towards organic-spintronics opens the way to develop magneto-optical phenomena in self-assembling organic structures.

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